SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Hydraulic Pump

PART NO.: 10201-0051-801, -802(Alt.)
includes:
Fittings, Connector:
10209-0038-801
10209-0077-801
10209-0036-801
O-Rings:
Type M83248/1
Plug, Seepage:
MS24391 J4L

FM CODE: A04

ITEM CODE: 20-01-29

REVISION: Basic

CRITICALITY CATEGORY: 1R

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 1, 2002

CRITICAL PHASES: Boost

SUPERCEDES: March 1, 2001

FMEA PAGE NO.: A-106

ANALYST: B. Snook/ S. Finnegan

CN 044

SHEET 1 OF 4

APPROVED: S. Parvathaneni

FAILURE MODE AND CAUSES: Compensator group fails to operate (System A and B) caused by:

- Contamination
- Compensator return spring breakage
- Improper assembly
- Compensator spool and sleeve jamming/breakage
- Stroking piston binding/breakage
- Cam return spring breakage

FAILURE EFFECT SUMMARY: Loss of TVC will lead to loss of mission, vehicle and crew. One success path remains after the first failure. Operation is not affected until both paths are lost.

REDUNDANCY SCREENS AND MEASUREMENTS:

1) Pass -All units are subject to ABEX ATP TP-675.

2) Pass -Hydraulic pressure measurements B58P1303C, B58P1304C.

3) Fail -Contamination

RATIONALE FOR RETENTION:

A. DESIGN

- The Hydraulic Pump is designed and qualified in accordance with end item specification 10SPC-0053. (All failure causes)
- Compensator sleeve is 52100 alloy steel heat treated to Rockwell hardness of C58-62 (310-350 KSI). (Compensator Spool and Sleeve Jamming/Breakage)
- Compensator spool is 135M nitrided steel heat treated to a Rockwell hardness of C26-32 (128-150 KSI) and is case hardened C65 to depth of .001-.015 inches. (Compensator Spool and Sleeve Jamming/Breakage)
- Stroking piston is 52100 alloy steel heat treated to a Rockwell hardness to C58-62 (310-350 KSI). (Stroking Piston Binding/Breakage)
- Cam return spring is 17-7 PH CRES. (CAM Return Spring Failure)
- Sleeve, spool and piston are machined to .002" tolerance or less which prevents misalignment and jamming. (Stroking Piston Binding/Breakage, Compensator Spool and Sleeve Jamming/Breakage)
- Compensator return spring is heat treated 17-7 Cres. (Compensator Return Spring Breakage)
- Fluid procurement is controlled per SE-S-0073. (Contamination)
- Material meets the requirements of MSFC-SPEC-522A. (Stroking Piston Binding/Breakage Compensator Spool and Sleeve Jamming/Breakage)
- Qualification testing verified design requirements as reported in ABEX Qualification Test Report AER-729. (All Failure Causes)

B. TESTING

- Acceptance test is performed per ABEX ATP TP-675 on each flight item. This includes visual examination, electrodepressurization valve test, break in run, overspeed test to 4755 rpm, functional test, which includes electrical bonding, depressurized start and pressurization and transient response not to exceed 125 ms. (All Failure Causes)
- During refurbishment, the pump is reworked per 10SPC-0131 and tested per ATP TP-675 to ensure proper operations. (All Failure Causes)
- Hydraulic fluid is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydraulic circuits per 10REQ-0021, para. 2.3.2.6. (Contamination)
- Effluent hydraulic fluid is verified for moisture content and cleanliness (water content and particulate count) from the rock actuator, the tilt reservoir, the rock reservoir and the tilt actuator per 10REQ-0021, para. 2.3.12.3. (Contamination)

o Proper operation of the compensating group is verified by test during: (All Failure Causes)

- High speed spin per 10REQ-0021, para. 2.3.15
- Hotfire per 10REQ-0021, para. 2.3.16

o Hydraulic fluid is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydraulic circuits during prelaunch operations per OMRSD File V, Vol. 1 Requirement Number B42HP0.010. (Contamination)

o Hydraulic fluid (effluent) is verified for moisture and dissolved air content per OMRSD File V, Vol. 1 Requirement Number B42HP0.011 and B42HP0.070. (Contamination)

o Helium is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board circuits per 10REQ-0021, para. 2.3.2.5.

The above referenced OMRSD testing is performed every flight.

C. INSPECTION

VENDOR RELATED INSPECTIONS

o Verification of compensator spring and spring guide materials is performed by USA SRBE PQAR per SIP 1258. (Compensator Return Spring Breakage)

o Nondestructive Evaluation (NDE) is performed on subassemblies by USA SRBE PQAR per SIP 1258. (Defective or Damaged Sealing Surface)

o Witnessing of acceptance testing is performed by USA SRBE PQAR per SIP 1258. (All Failure Causes)

o Verification that Parker Abex has performed and accepted all required Hydraulic Pump refurbishment and inspections per TP-1210 by USA SRBE PQAR per SIP 1258. (All Failure Causes) CN 044

o Critical Processes/Inspections:

- Nitride per MIL-S-6090
- Heat treat per Rockwell C58-62 per PS-208 (Guideline spring only)
- Heat treat per MIL-H-6875
- Penetrant inspection per ASTM E1417
- Magnetic particle inspection per ASTM-E-1444.

KSC RELATED INSPECTIONS

- o Helium cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board circuits per 10REQ-0021, para. 2.3.2.5.

- o Hydraulic fluid cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydraulic circuits per 10REQ-0021, para. 2.3.2.6. (Contamination)

- o The moisture content and cleanliness (water content and particulate count) of the effluent hydraulic fluid from the rock actuator, the tilt reservoir, the rock reservoir and the tilt actuator are verified per 10REQ-0021, para. 2.3.12.3. (Contamination)

- o Hydraulic fluid cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydraulic circuits during prelaunch operations per OMRSD File V, Vol. 1 Requirement Number B42HP0.010.

- o Proper function of TVC system is demonstrated during hotfire operations per 10REQ-0021, paras. 2.3.11, 2.3.15 and 2.3.16 respectively for: (All Failure Causes)

  - Low speed GN2 spin
  - High speed GN2 spin
  - Hotfire

- o Verification of hydraulic fluid (effluent) sample is performed for moisture and dissolved air content per OMRSD File V, Vol. 1 Requirement Number B42HP0.011 and B42HP0.070. (Contamination)

  Pump operation is monitored during final countdown from T-15 sec. to T-7 sec. by the automatic GLS system per OMRSD File II, Vol. 1, Requirement Number S00FR0.070. (All Failure Causes)

D. FAILURE HISTORY

- o Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- o Not applicable to this failure mode.